



# Wood Heat

Minnesota Department of Commerce Energy Information Center

**Wood is a widely used heating fuel: approximately a third of all Minnesota homes use wood at least occasionally to provide space heat. Wood can be an effective and economical source of heat, provided all necessary steps are taken to ensure efficiency, environmental health, and fire safety.**

Selecting and  
installing a stove

Chimneys and  
stovepipes

Operating a stove  
properly



#### Related Guides:

Home Heating  
Combustion & Make Up Air

The emphasis in this guide is wood heating safety, starting with a general description about the type of equipment available, followed by instructions on proper installation, maintenance, and operation. Although the guide deals primarily with stoves used for heating, the tips about installation, operation, and maintenance can be applied to any wood appliance.

A few words of caution: If you are considering becoming a first-time user of a wood stove, you should examine your own expectations of what a wood stove will provide. Although the new stoves on the market are much improved over previous models, they are not a substitute for a central heating furnace.

#### Types of wood stoves

A variety of wood stoves are in use today, but anyone who wants to heat efficiently and cleanly with wood will want a model that meets Environmental Protection Agency (EPA) standards. Most new stoves sold today meet these efficiency and emission standards which were established in 1988. The certified wood stoves of today have efficiencies ranging from 63 to 78 percent, compared to 40 to 50 percent for stoves sold in the 1970s and '80s. They also emit less than one-tenth the amount of smoke.

Three types of residential stoves meet these standards: catalytic, high tech non-catalytic, and pellet burners.

**Catalytic stoves.** These stoves use a catalytic combustor that operates on the same principle as the catalytic converter in your car. In a conventional wood stove, as much as 30 percent of the fuel can go up the chimney as unburned fuel when the unit operates at moderate temperatures—between 500 and 600 degrees F. For complete combustion, the conventional stove must burn at nearly 1,000 degrees F. The catalytic stove, in contrast, obtains complete combustion at approximately 500 degrees F. This increased combustion gives more “mileage” from the fuel and produces less air pollution, particularly on mild autumn and spring days when the chimney’s natural draft is reduced and the building heat loss is low.

In operating a catalytic stove, make sure that the combustor is ignited. The stove should burn moderately for 10 to 30 minutes until it reaches the 500 degrees F required for ignition. It is best to check the temperature using a catalyst temperature probe (see Figure 1), which may come with the stove or be purchased separately. Maintain the temperature within 1,200 to 1,400 degrees F; significant damage will occur above 1,800 degrees F.

Only untreated, well seasoned wood should be used and the combustor should never be scraped, jarred, or blown out with an air compressor. If these guidelines are followed, the combustor should be effective for up to 12,000 hours (about three to six years). If increased smoke comes out

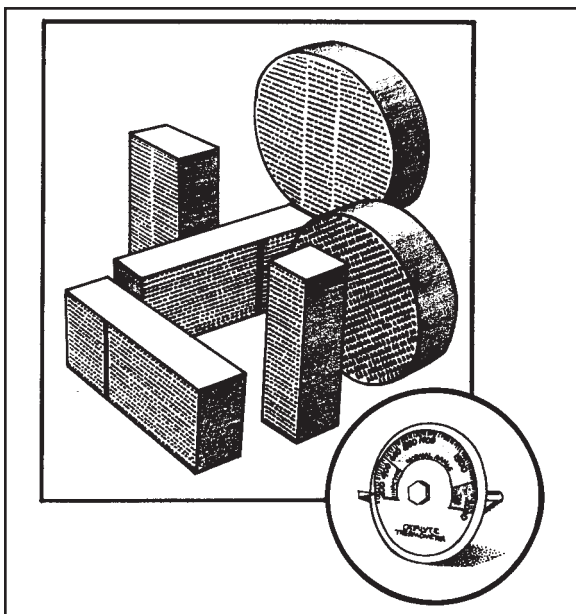


Figure 1  
Catalytic combustors come in a variety of shapes and sizes; bottom right is a typical temperature probe with an operating range of 500° to 1800°F.

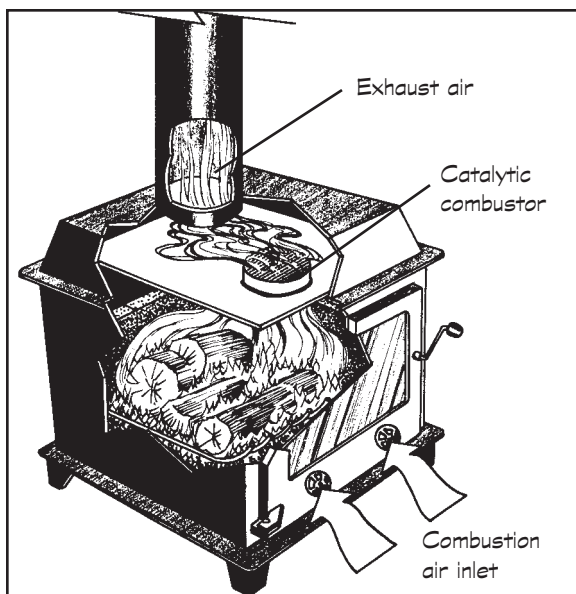


Figure 2  
Catalytic stoves are highly efficient and allow the most user control.

of the chimney at low burning temperatures, or if the unit has difficulty maintaining a temperature of 900 to 1,000 degrees F, the combustor probably needs replacing. The EPA requires that combustors should be easy to inspect and replace and that they be guaranteed for at least two years. The cost of replacing a combustor ranges from \$75 to \$250, but in a two year period, the combustor should save more than that in fuel savings.

It is possible to retrofit a stove with a catalytic combustor, but the add-on devices are usually only about half as effective as a new unit with a built-in combustor.

A well designed catalytic stove (Figure 2) offers the following benefits:

- Produces 80 to 90 percent less pollution at low to moderate temperatures.
- Provides combustion efficiency of at least 72 percent when the stove is new.
- Uses 25 to 30 percent less firewood.
- Requires less frequent chimney cleaning because the clean burn produces less creosote.
- Provides increased safety because less creosote means less chance of chimney fire.
- Allows the user to throttle down the fire manually.

**High tech non-catalytic wood stoves.** Many EPA certified stoves achieve high rates of combustion without a catalytic combustor. Non-catalytic stoves (Figure 3) are slightly less efficient, with ratings from 63 to 75 percent, and they often require more frequent refueling. They offer advantages, however: a wider choice of fuel can be used and there is no need to replace a catalytic combustor. A “non-cat” stove offers the following features:

- Preheats incoming air to keep combustion temperatures higher for more complete combustion.
- Stationary baffles direct gases back to the combustion zone for more complete burning.
- Pre-heats secondary air to reignite gases and reduce fuel loss up the chimney.
- Stationary air inlets ensure adequate air for combustion.

- Small fireboxes lined with firebricks maintain high temperatures in the combustion zone.

**Pellet stoves.** Some EPA certified stoves burn fuel pellets manufactured from wood or other biomass. With a pellet stove (Figure 4), you load batches of fuel into a hopper. A motorized auger, controlled by a dial or thermostat, then moves the pellets into the stove as needed. A small fan controls air-flow in the combustion process.

When buying wood pellets, pay attention to the ash content, making sure the particular ash level is compatible with your stove. Most stove dealers should be able to give you information on where to obtain the appropriate pellets.

Pellet stoves, like the other stove types, have advantages and disadvantages. The fans and augers consume only about 150 watts of electricity, but they can't provide heat during power outages. Fuel must be obtained from a dealer, rather than a local wood lot (pellet prices, however, have remained fairly stable). Pellet stoves are more expensive than most wood stoves but they don't require expensive chimney systems. They also have controlled air-to-fuel ratios that allow them to achieve nearly complete combustion, and their excellent heat transfer ranks them among the lowest in smoke emissions and highest in efficiency. Some pellet stoves also will burn corn, which in some areas can be a cost-effective fuel.

Basically, pellet stoves are a good choice if you do not have a reliable wood supply or if you want to avoid installing a more expensive chimney system.

**Other equipment.** Aside from the traditional wood stove, there are a number of other equipment options, including fireplace inserts, wood burning furnaces, and outdoor boilers. A detailed discussion of the pros and cons of this equipment is outside the scope of this guide. The resource section at the end of this guide will help you research these options.

## Selecting a wood stove

In deciding which of the three types of stove is right for you, consider the initial cost, the operating cost (including fuel and electricity for fans), availability of fuel, appearance, and insurance company requirements. Talk with your insurance agent before buying a stove. Some insurance companies

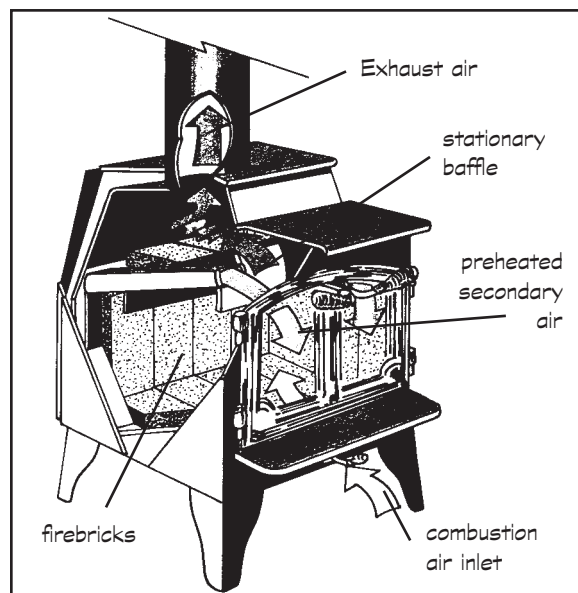


Figure 3

High tech non-catalytic stoves are slightly less efficient than catalytic stoves, but are also less expensive and will adapt to a wider choice of fuel.

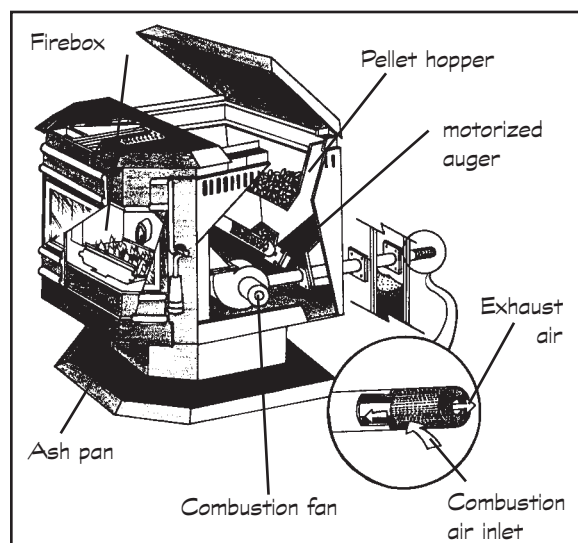


Figure 4

In pellet stoves, a fan pulls air into the firebox through a two-part pipe system that also acts as a heat exchanger as the outgoing exhaust air warms the incoming air for combustion.

## Tip

Wood stoves must be installed to meet fire protection standards.

## Before buying and installing a wood stove

- Check first with your insurance agent to make sure you can continue to have house insurance and what the rates will be.
- Next, apply for a permit from your local building inspection department. The Minnesota Uniform Fire Code requires solid fuel burning appliances to be listed and installed in accordance with the terms of their listing. If your appliance is not listed, it can be approved provided it is installed in accordance with the Minnesota Fire Code. Your local building inspector can provide you with the specific requirements of the Fire Code.
- If you reside in rural Minnesota or in a community that does not have a building inspector, you can discuss the specific installation procedures, clearances from combustible materials, and other requirements of the Minnesota Fire Code by consulting with your insurance company or local fire department or by writing the State Fire Marshal Division, Minnesota Department of Public Safety, 444 Cedar Street, Suite 145, St. Paul, MN 55101-5145 (<http://www.dps.state.mn.us/fmarshal/>)

will not provide coverage for a home that is heated by a wood stove. Others will, but some charge very high rates. You may need to have your installation inspected by the insurance company before your coverage begins. Before buying a stove, you should also check with your local municipality regarding required permits and inspections.

**Emissions, efficiency and safety certification.** Make sure the stove you are buying meets efficiency, emissions and safety standards. As previously noted, all new stoves from major manufacturers sold today must meet EPA efficiency and emissions standards. The stoves carry both a permanent and temporary label. The temporary label compares the stove's average performance with the emissions standards, allowing you to compare one stove to another. The permanent label (Figure 5) shows emissions and efficiency levels for a range of heat output. Use this information to select the proper size unit for the space you will be heating.

The Minnesota Building and Fire Codes require solid fuel burning appliances to be listed and installed in accordance with the terms of their listing. Your local authority can approve unlisted appliances, but they must be installed in accordance with standards of the National Fire Protection Association (NFPA) Standard 221.

A listed stove has been tested to meet standards established by organizations such as the International Council of Building Officials (ICBO) and Underwriters Laboratory (UL). Safety labels

must be permanently affixed to a "listed" stove. The label must state the name of the laboratory that conducted the safety test, the test standards that were applied, and basic installation requirements for the stove. If there is no label permanently attached, the stove has not been tested and is not listed for safety.

**Features promoting efficiency, clean-burning.** Whatever type of stove you buy, look for features that promote clean, efficient burning, such as:

- Air supply ducts that allow incoming air to be preheated and directed into the active flames, increasing combustion efficiency.
- Baffle plates designed to regulate the flow within the stove, directing incompletely burned gases to the active fire, resulting in better combustion efficiency.
- Firebox insulation sufficient to maintain an average firebox temperature slightly above the 1,000 F required for clean combustion and to protect the metal surfaces of the firebox. Without firebox insulation, the fire is continuously cooled as the heat escapes to the room air surrounding the stove.
- Secondary air supply that allows for the combustion of unburned gases that would otherwise escape up the chimney and pollute the air.

**Other design features.** These design features do not affect efficiency of the stove, but should be kept in mind for your own convenience.



- An ash pan eases removal of ashes.
- A circulating stove, which uses fans to circulate warm air, is safer for households with children, since its hot stove surfaces are covered by an outer jacket. A radiant stove has no outer jacket and heats principally by infrared radiation (heat moving by long wavelength from one surface to another) considered by some to be a more comfortable form of heating.
- Door location and size determine how easily the wood fuel can be loaded.
- Firebox size determines how big the wood pieces can be.
- A cast iron stove versus plate steel is largely a matter of preference. Cast iron may crack, plate steel may warp, and both may corrode, but neither has been proven more efficient than the other. Top quality tight-fitting construction, rather than material, is the key to a good stove.
- There are two types of automatic damper controls - one type completely opens or shuts the damper and the other makes gradual adjustments. Each has its own characteristics, but average room temperatures are the same for comparable systems.
- Liners, either firebrick or steel, extend the life of the firebox and are much less expensive to replace than the stove itself. They also provide thermal mass to store heat.

**Sizing a stove.** The most common mistake in sizing a stove is selecting a stove that is too large for the area to be heated. An experienced wood dealer can be the best source of advice on sizing. The primary factors involved in sizing a stove are:

- Volume of open area to be heated.
- Your home's insulation and weatherization level.
- Rate of infiltration.
- Average outside temperature during the heating season.
- Location of stove within the building.
- Volume and placement of combustion air/draft air inlet.

## AVERAGE EMISSIONS AND EFFICIENCY PERFORMANCE

**SMOKE** 3.4 grams/hour

**DEQ Catalytic Standard**  
6 until 07/88  
4 after 07/88

**EFFICIENCY** 78.1 %

**No DEQ Standard**



### HEAT OUTPUT RANGE

11,609 to 53,093 Btu/hour

**Manufacturer:** Travis Industries, Inc. Kirkland, WA

**Model:** LOPI® Flex/95 Series

**Design No:** FS, FL, LX

(Performance may vary from test values depending on actual home operating conditions)

Pursuant to OAR 340-21-100 to 190, this woodheating appliance is certified as meeting The Oregon Department of Environmental Quality emission standard and is approved for sale in the State of Oregon.

Figure 5

A permanent label relating emissions and efficiency to heat output is required by the EPA and helps in sizing the stove.

## Installing a wood stove

Proper installation of a wood stove is necessary for clean and efficient operation and - even more important - for safety. Improperly installed wood stoves and chimneys are the major cause of house fires. As previously noted, Minnesota has a statewide fire code requiring wood stoves to be installed according to certain standards. Always follow manufacturer's instructions, paying particular attention to clearance from combustible surfaces. It is advisable to have professional help in installing a stove.

**Location.** Your stove should be located in a frequently used area such as the living room or family room. When you have decided on a location, inspect the structural support under the floor on which the stove will be placed to make sure it is adequate.

The best place for a stove is in the center of the room, where it can radiate heat in all directions. The worst place to put a stove is in a closet or alcove. Stoves are often placed in the middle of an outside wall and vented straight up through the roof. In any case, installation requires proper

### Tip

To achieve maximum safety and reliability of your equipment, follow the manufacturer's installation instructions exactly.

## Tip

Cheating  
on clearances  
means a certainty  
of a fire!

clearance between stove system surfaces and their surroundings to keep your home safe from fire. Remember, heat transfer from the walls of the stovepipe and chimney, as well as from the stove, must be considered.

### **Clearances from combustible materials.**

Constant exposure to heat lowers the temperature at which a material will begin to burn. A joist or rafter too close to the chimney walls, or a wall stud too close to the stove and its stovepipe, will overheat and ignite. Clearances are specified by safety codes to prevent overheating of combustible materials by keeping them at a safe distance. Cheating on these clearances means a certainty of a fire!

Each manufacturer of listed stoves is required to specify minimum clearances. These clearances vary, depending on the construction of the stove. When installing your wood heating system, you must follow the manufacturer's instructions. If you install a stove for which there are no instructions, you should observe the clearances listed in the section on clearances later in this guide.

A noncombustible material is defined as that which will not ignite or burn when subjected to flame or intense heat for long periods of time. Steel, iron, brick, tile, concrete, slate, and glass are noncombustible.

All walls containing wood framing are combustible, including plaster and sheetrock walls on wood lath or wood studs. Nearly every wall and ceiling in residential buildings contains wood. If you are unsure about your home, assume that the wall or ceiling is combustible and maintain proper clearance.

A floor is considered noncombustible if it is concrete, slab-on-grade design, or solid concrete with steel or concrete-but not wood-supports. An existing masonry hearth extension is noncombustible if no wood forms have been left in place below it, and if stove placement allows at least 18 inches of hearth extension in front of the loading door.

All wood floors carpets and synthetic materials are considered combustible and must be protected in an approved manner. Other combustible materials include furniture, draperies and newspaper.

All stoves and stovepipes require a minimum clearance to unprotected combustibles on top and on all sides of the wood stove.

No clearance is needed for stoves or stovepipes to noncombustible walls (i.e., concrete walls or dirt floors). It is a good practice, however, to allow six inches or more for good air circulation and heat dissipation.

### **Protective or clearance reduction systems.**

Installing a clearance reduction system will reduce heat transferred to the combustible surface, allowing specific clearances to be lowered. See the section on clearances later in this guide.

A variety of prefabricated clearance reduction systems are available through wood stove and fireplace dealers. Always look for the safety listing and make sure the system is designed to be used with a wood stove. The manufacturers of these tested and listed accessories provide specific installation instructions that must be followed.

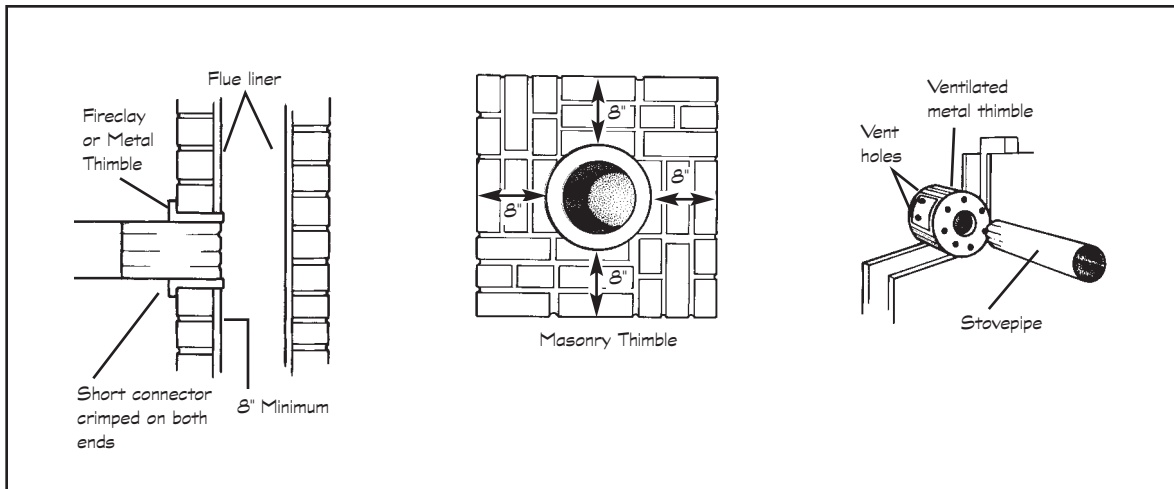
**Floor protection.** All combustible floors must be protected. The only base on which a stove can be installed without special protection is a noncombustible floor or properly built hearth extension. Manufacturers of listed stoves usually specify the type of material required for floor protection and these materials should be used. If the manufacturer does not specify a material, you may purchase one or more of the safety tested and listed prefabricated stove boards on the market.

## **Chimneys and stovepipes**

A chimney is a critical part of your wood heating system. It carries smoke out of the house, and creates the suction or draft necessary to draw air to the fire. A well designed chimney allows the stove to operate cleanly, producing a minimum amount of smoke and creosote. Chimneys used with wood stoves must meet "all fuel" standards, also called "Class A."

The chimney connector or vent connector is commonly known as the stovepipe. It connects the stove to the chimney. A stovepipe has a single metal wall and may not pass through a well, ceiling, attic, closet, or any concealed area.

Studies show that most house fires related to wood heaters originate around the chimney or



Thimbles must be used to connect the stovepipe to the chimney.

stovepipe. According to the U.S. Consumer Product Safety Commission, house fires involving chimneys are caused primarily by creosote buildup in the chimney (creosote is soot and tar produced as a by-product of wood burning), metal chimneys too close to combustibles, chimney failure, improper construction or deterioration of a masonry chimney, and improper installation of a chimney connector (stovepipe). Before building or installing a chimney and stovepipe, therefore, it is very important to contact the fire marshal's office and the local building code official for information on making your system safe.

Chimney height is critical to creating proper draft and meeting fire codes. The chimney should extend at least three feet above the point where it exits the roof, and should be a minimum of two feet higher than any part of the roof within ten feet. (See the 3-2-10 rule.)

For safety reasons, the stovepipe should be as short as possible, but installations with five feet or so of pipe are acceptable. Keep in mind that the most trouble-free system will have few, if any, horizontal pipe sections and elbows. A vertical

stovepipe gives the best possible draft and allows creosote and soot to fall back into the stove to be burned. Long runs of stovepipe should be avoided because they inevitably fill up with soot, ash, and creosote.

**Thimbles.** Use a metal or fire clay thimble when passing a stovepipe through noncombustible walls. The thimble should be permanently cemented into the masonry chimney and extend through the chimney wall to the inner face or liner, but not beyond. Push the short section of stovepipe, crimped on both ends, into the thimble and secure it with high temperature sealant. The stovepipe should extend as far as possible into the thimble but should not stick out into the chimney.

If you must vent through a combustible interior or exterior wall, contact the fire marshal for instructions. A stovepipe may never pass through a ceiling, closet, or concealed area. For these situations a "Class A" chimney is required. Once the stovepipe connects to the chimney, it must remain a chimney from that point on. No further use of stovepipe is allowed.

## Smoke detectors

Smoke detectors should be installed on every level of your home. If you burn wood, it is even more important to have working smoke detectors. Fires can smolder for hours, long after flames have gone out.

The majority (75 percent) of fatal fires occur in residences. Most fatal fires occur between midnight and 6 a.m., when people are asleep. Smoke detectors are designed as an early warning device to awaken sleeping residents.

Test all smoke detectors monthly and change batteries once a year. Make sure you and your family have an early warning that allows you time to escape in the event of a fire.

## Tip

All chimneys need to be regularly inspected for deterioration and creosote buildup

**Masonry or metal chimney.** Whether to have a metal or masonry chimney depends on a number of factors: both types have advantages and disadvantages.

Metal chimneys are often less expensive than masonry chimneys and are more adaptable to installation in existing houses. (Some insurance companies, however, will not approve coverage for homes with a metal chimney; be sure to check with your insurance company before installing a metal chimney.) Most masonry chimneys require the work of an experienced mason and are usually built at the same time as the house.

A chimney cap is often added to keep out rain. On masonry chimneys, a flat plate of steel or concrete is most often used, but more stylish ceramic and metal caps are available. Caps for safety tested and listed manufactured chimneys are also available.

Masonry chimneys are very durable, and some homeowners consider them more attractive than prefabricated chimneys. In addition, massive interior masonry chimneys will store heat longer and continue to release this heat to the room long after the wood fire has subsided.

Masonry chimneys also have disadvantages. They are expensive to build and more difficult to inspect and maintain than prefabricated chimneys. In addition, masonry chimneys are often built on an exterior wall, reducing heating efficiency. This exposure to cold outdoor temperatures leads to greater heat loss and higher accumulations of creosote deposits.

Whether you have a masonry chimney built or plan to use an existing one, safety should be your prime consideration. A masonry chimney is a very heavy structure that must be able to withstand many years of use, including occasional chimney fires in which temperatures may reach 2,700 degrees F.

Safety do's and don'ts when connecting a wood stove to a masonry chimney:

- Make sure the stove will have enough air for combustion and proper draft for that size chimney. See our Combustion and Makeup Air Guide.

- Check the general condition of an existing chimney. Look for loose bricks and cracks in the mortar that might allow creosote to leak out or sparks to escape and ignite creosote or dry structural wood. Have a competent mason do any needed repairs.
- Many older homes have chimneys that are in good structural shape but do not meet "all fuel" or "Class A" requirements. A typical example is a chimney constructed of four-inch brick without a fire clay liner. These chimneys can be made safe by lining them with safety listed liners.
- Each wood burning appliance must have its own flue (a fireplace is considered an appliance). If you have more than one fireplace, check the chimney to make sure that a flue exists for each appliance.
- Frequently in older homes an existing masonry chimney may have served more than one appliance in various rooms. It is critical to locate and seal these unused entry ports or breachings. Unused breachings are often covered with a thin metal "pie plate" cover. They may be hidden by paneling or plaster, especially if the house has been remodeled. Unused breachings should be sealed using masonry and fire clay mortar to make the former entry port as sound as the rest of the chimney.

**Chimney inspection and cleaning.** All chimneys require regular inspection for deterioration and creosote buildup. A correctly built chimney can settle and require repair within time - a poorly built chimney is dangerous from the start. The chimney should be inspected and cleaned at least once a year, as often as biweekly if you use your wood stove daily. Remember that a cleanout opening is required and provides a convenient way to remove creosote after a cleaning. The opening should be more than two feet below the stovepipe entry port, should be made of ferrous metal frame, and must have a door designed to remain airtight when the stove is in use. Also, disassemble the smokepipe and inspect it annually.

Clean the chimney when creosote deposits are one-quarter inch thick. Inspect the flue at both the stove end and chimney top. Remember that cooler surfaces will have the thickest creosote deposits (these are usually near the top).



## The 3-2-10 Rule

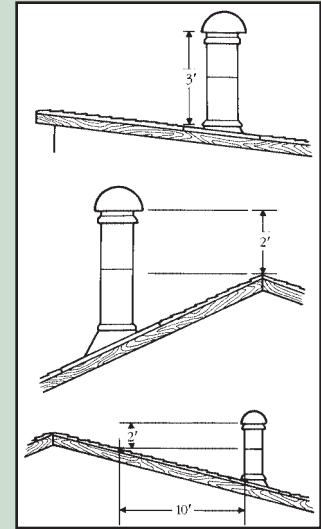
Chimney height is critical to creating proper draft. The chimney must extend at least three feet up from the roof and be at least two feet higher than any part of the roof within ten feet, measured horizontally. Measurements are made from the high side of the roof to the top of the chimney wall.

If your chimney is 10 feet or more from the roof ridge, you may use Table 1 directly. If the ridge is closer than ten feet, calculate the proper height by using the numbers from Table 1 in the following formula:  $\text{Roof slope} \times \text{Distance to ridge} + 2 \text{ feet} = \text{Required height above the roof}$ .

For example, a chimney on a 5/12-slope roof located 6 feet from the ridge requires  $(5/12 \times 6 \text{ ft.}) + 2 \text{ feet} = 4 \text{ feet, } 6 \text{ inches above roof}$ .

Table 1 Minimum Chimney Heights Height above the roof ridge 10 feet or more from chimney	
Roof slope*	
Flat	3'
1/12	3'
2/12	3'8"
3/12	4'6"
4/12	5'4"
5/12	6'2"
6/12	7'
7/12	7'10"
8/12	8'8"
10/12	10'4"
12/12	12'

\* Roof slopes are given in feet of rise per 12 feet of run. A 6/12 slope rises 6 feet per 12 feet of horizontal run.



You can have a professional clean your chimney or you may choose to clean it yourself. Wear a protective mask and goggles and gloves and use a quality steel-bristle brush. You'll also need to clean the inside of the stove and stovepipe. If you suspect leaks or cracks in your stove system, call in a professional to perform a leak test. If any leaks are found, have them repaired immediately.

**Chimney fires.** Chimney fires occur when creosote on the inside of a chimney wall burns. Chimney fires most likely occur during a very hot fire, as when cardboard is burned or when normal wood is burned at a very high rate. A crackling sound is often the first sign of the overfiring of a stove that precedes a chimney fire. As intensity grows, the stovepipe may shake violently, air will be forcefully drawn in through the stove, and the stovepipe will glow red hot. Another symptom of overfiring a stove is "back-puffing" - small puffs of smoke come out of the combustion chamber making a sound similar to a heavily muffled backfire from a car. A tall plume of flame and sparks will rise from the top of uncapped chimneys.

When a chimney fire starts:

- Close the dampers. This limits the air supply.
- Call the fire department immediately.
- Wet down the roof and other outside combustibles to prevent fires started by shooting sparks and flames.
- Keep a close watch on all surfaces near the chimney.
- Have the chimney inspected before using it again. Cracks or openings caused by the fire may allow creosote to leak out. The next chimney fire may include your attic or interior walls near the chimney.

### Combustion air

Minnesota building codes require an outdoor air inlet to ensure adequate air for combustion. The size of the inlet required depends on a number of variables, such as type and height of chimney and heating size of the stove. Check with your building code officials. Without an outdoor air supply, your

## Carbon Monoxide Alarm

The Energy Information Center strongly recommends installing a carbon monoxide (CO) alarm. The alarm will sound after CO reaches a dangerous level. Make sure the alarm has a UL listing. You should buy an alarm with a low-level digital display and a memory, in addition to the simple alarm. These features help diagnose a problem if one is discovered. CO alarms need to be tested regularly and cleaned as indicated in the manufacturer's instructions. If the unit is battery operated, the alarm should be tested weekly and the battery replaced at least once a year. For more information on CO and its health effects, call the Minnesota Department of Health at 651-215-0909 or visit their web site: <http://www.health.state.mn.us/>.

stove will take combustion air from the room, creating the potential for dangerous backdrafting of noxious gases and smoke into the house. With inadequate combustion air, your central furnace or water heater may backdraft toxic gases, even if the fireplace or stove appears to work properly.

Some wood stoves draw outdoor air directly into the stove, ensuring an adequate combustion air supply and reducing unwanted infiltration. If your stove does not have this feature, call the Energy Information Center and ask for a copy of "Combustion and Makeup Air." This guide provides suggestions on how to install an air inlet. For most homes that have been weatherized even moderately, an air inlet is absolutely necessary.

### Fuel

The kind of wood you burn affects the amount of heat you receive. Density and moisture content of the wood affect combustion. Dense species, such as white oak, that are well seasoned or dried have higher energy content per volume. Burning "green" wood, which contains as much as 50 percent water consumes a large amount of heat energy simply to dry the wood prior to combustion. "Dry" wood has 15 to 20 percent moisture by volume.

Wood fuel is measured in cords; with one standard cord equaling 128 cubic feet (4x4x8), assuming the wood is cut into four-foot lengths and ranked. If the sale is of sawed wood, a cord is 100 cubic feet when ranked, or 160 cubic feet when thrown irregularly or loosely into a truck. If the wood is sawed and split, a cord is 120 cubic feet when ranked and 175 cubic feet when thrown loosely into a truck.

Sometimes wood is measured in "face cords," or by other definitions often smaller than a standard cord, so make sure you know what you are buying. You should get a bill of sale with clearly defined volumes.

### What not to burn:

- Household garbage can produce noxious and corrosive gases and can foul a catalytic combustor.
- Newspaper and magazines cannot be used in catalytic stoves because the lead and other metals in the ink can foul the combustor.

- Plastics and junk mail can cause lethal fumes.
- Treated or painted wood can produce very toxic and sometimes explosive gases.

### Operating a stove properly

To ensure that you operate your stove efficiently and safely, observe the following guidelines.

- Start the fire with dry kindling and with air inlets and dampers wide open for maximum air.
- Add two or three pieces of dry wood, keeping air inlets and dampers open.
- Never light or rekindle a stove fire with kerosene, gasoline, or charcoal lighter fluid - the result can be fatal.
- In 15 or 20 minutes, when the fire is burning well, adjust air inlets and dampers to control the speed of burn.
- Add only one or two pieces of firewood at a time and provide more air each time fuel is added.
- Determine if you have the proper air supply by checking what's coming out of the chimney - dark smoke indicates that more air is needed. A note of caution: most manufacturers of cast iron stoves recommend keeping the first fires small to break in new stoves gradually. New stoves always smoke on start-up as the paint and sealants are heated. Be prepared to open windows and doors for ventilation.
- Always keep a fire extinguisher and a bucket of sand nearby. Use water on wood stove fires only in extreme emergencies: the water turns to steam, scatters hot ash everywhere, and can crack cast iron stove parts and damage chimneys.
- When refueling, open the damper and air inlet fully a minute before opening and loading. For airtight stoves, this is especially important because a sudden rush of air into the chamber can trigger a small explosion. Escaping gases can seriously burn anyone standing nearby. All openings in operating stoves should be opened slowly, and the operator's face should be kept well back from the stove for a few minutes after opening.

## Creosote

The perfect fire would result in complete combustion, leaving only water and carbon dioxide as by-products. In reality, combustion is never complete. Hot unburned gases, solid particles, and tar-like liquids go up the flue as smoke. As these substances contact the cooler flue surface, they condense. When the water evaporates, it leaves behind a tar called creosote, which builds up fire after fire into a crusty black layer.

Creosote is the enemy of wood stove users and should be feared because it causes chimney fires. It is highly flammable. Large deposits can block the flue and make the stove smoke.

The amount of creosote formed in the flue depends upon a number of factors. The smokier the fire, the bigger the creosote problem. When the fire is hot enough, creosote burns along with the other organic compounds in the wood. A good hot fire is a cleaner fire. It is easier to make a small fire hot. Don't overload the stove; it will smoke.

High moisture wood leads to higher creosote formation because the water vapor inhibits combustion, making the fire cooler and smokier. The more smoke, the more creosote. The cooler temperatures result in more condensation on the flue walls.

With any type of wood, smoke production is greatest when fresh wood is added or when air supply is turned low. At these times, combustion efficiency is lowered, and heavier smoking results.

Increased levels of creosote are associated with softwoods because of their high resin contents. Dry hardwoods have a reputation of generating the least amount of creosote. Seasoned softwood fires will not produce large amounts of creosote.

To cut down on creosote deposits:

- Burn well-seasoned hardwood.
  - Keep a brisk burning small fire and maintain a good draft.
  - Add small loads of wood frequently rather than fewer large loads.
  - Don't ever add a full charge of green wood-this will generate large amounts of creosote.
  - A wood stove fire should not be allowed to smolder all night long, with exception of a catalytic stove fire. For the catalytic stove, add the last charge of wood an hour before retiring, reducing the wood to cleaner burning charcoal.
  - Minimize the length of stovepipe connecting the stove to the chimney.
  - The only way to remove creosote safely is by a traditional chimney cleaning that includes scraping the creosote from the inside of the flue.
- 
- When refueling a non-catalytic stove, allow the fire to die down some before adding fuel. For efficiency and safety you are better off burning many small hot fires rather than one slow-burning fire.
  - Don't overfire the stove: red hot stovepipes and overheated fuels will warp and damage the metal and can cause chimney fires.
  - Watch out for handles and surfaces too hot to touch with bare hands.
  - Before going to bed or leaving the house, always check to see that the stovepipe damper is open, the stove door securely fastened, and combustibles a safe distance from the stove.
  - Ashes that seem cool may contain hot embers, so always place ashes in a metal container with a tight fitting lid. (Leave an inch or more of ashes to protect the bottom of the firebox.) Place the container on a noncombustible floor or on the ground, 15 feet away from combustible materials or buildings until final disposal. Embers/ashes can remain hot for up to 48 hours.
  - Do not put green or wet wood on top of the stove to dry it. Such a practice is very dangerous. Do not, in fact, put anything on top of the stove unless it is absolutely fireproof.
  - Do not store flammable liquids near the stove, especially in workshops, basements, and garages.
  - If you suspect you have a problem, call the fire department as soon as possible. Don't take a chance with fire.

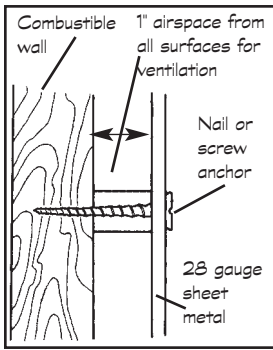


Diagram 1

Noncombustible spacers such as stacked washers, small pipe, tubing, or electrical conduit can be used to create the 1" air space. Masonry walls may be attached to combustible walls using wall ties. Do not use fasteners directly behind stovepipe or stove.

## Clearances for Wood Stoves and Stovepipes

*(Clearances listed in this section should be observed when manufacturer's installation instructions are not available. When manufacturer's instructions are available, compare the recommended clearances with those listed here. Using the larger clearance will provide a margin of safety.)*

**Unprotected floors, walls and ceilings.** All stoves require a minimum 36-inch clearance to unprotected combustibles above and on all sides of the stove. A single wall stovepipe must have an 18-inch clearance to combustible walls and ceilings, measured at right angles to the pipe.

No clearance is needed to noncombustible walls (i.e., concrete). It is good practice, however, to allow six inches or more for good air circulation and dissipation of heat.

The only base on which a stove can be installed without special protection is a noncombustible floor or properly built hearth extension. Such a base should extend at least 18 inches on all sides of the stove.

**Protected walls and ceilings.** A wood stove and stovepipe may be placed closer than 18 inches to a combustible material if the material is protected in an approved manner with either a home-built or a prefabricated clearance reduction system.

The two most common types of home-built clearance reduction systems use 24 gauge sheet metal (galvanized steel, aluminum, copper) or 3-1/2-inch (4-inch nominal) thick masonry wall. Either of these materials must be spaced out one inch from the combustible surface; that is, they must be anchored to the combustible surface so that there is a one-inch air space between the sheet metal or masonry and the combustible material. (Diagram 1) With sheet metal, noncombustible spacers are used to maintain the one-inch air space. With a masonry wall, metal wall ties and furring strips, if needed, are used to anchor the brick to the wall. Do not place the spacers or wall ties directly behind the stove or stovepipe. The one-inch air space must be maintained around the entire perimeter of the clearance reduction system so that air flows freely and removes heat. This prevents the combustible surface from catching fire.

Sheet metal or masonry attached to the wall without this air space offers no protection and cannot be considered a clearance reduction system.

A variety of prefabricated clearance reduction systems are available through wood stove and fireplace dealers. Always look for the safety listing and make sure the system is designed to be used with a wood stove. The manufacturers of these tested and listed accessories provide specific installation instructions that must be followed.

Table 2 shows some clearances required using clearance reduction systems on walls and ceilings. These clearances are also depicted in Diagrams 2, 3, 4, and 5. (Masonry clearance reduction systems are used only on walls, not ceilings.)

The clearance reduction system must be centered behind or above the stovepipe to protect the wall or ceiling. The system should extend 36 inches past the stove in height and width, measured diagonally. If the stove is placed farther from the wall than the minimum distance required, the width and height of the clearance system can be determined by measuring from the side and top edge of the stove to the unprotected wall. This distance should be no less than 36 inches. The larger the distance between the stove or stovepipe and the wall, the smaller the clearance reduction system needs to be.

Some manufacturers may specify greater clearances. For a complete listing of clearances using clearance reduction systems, contact the fire marshal's office.

**Protected floors.** All combustible floors must be protected, and many types of materials are available for floor protection. Manufacturers of listed stoves usually specify the type of material required and, if available, these materials should be used. If the manufacturer does not specify a material, you may purchase one or more of the safety tested and listed prefabricated stove boards on the market.

Floor protection should extend 18 inches in front of the loading door to prevent damage to the floor from sparks, embers, ash or radiant heat. It should also extend 18 inches or more on the remaining sides of listed stoves, unless the manufacturer specifies a greater amount. (Diagram 6)



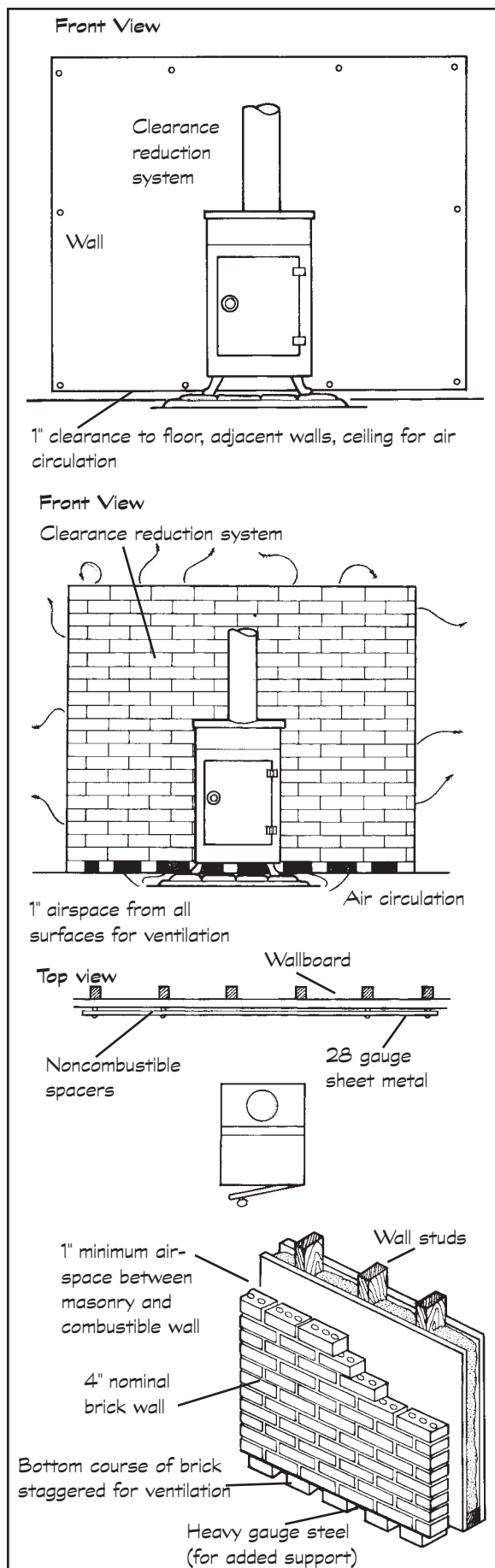


Diagram 2

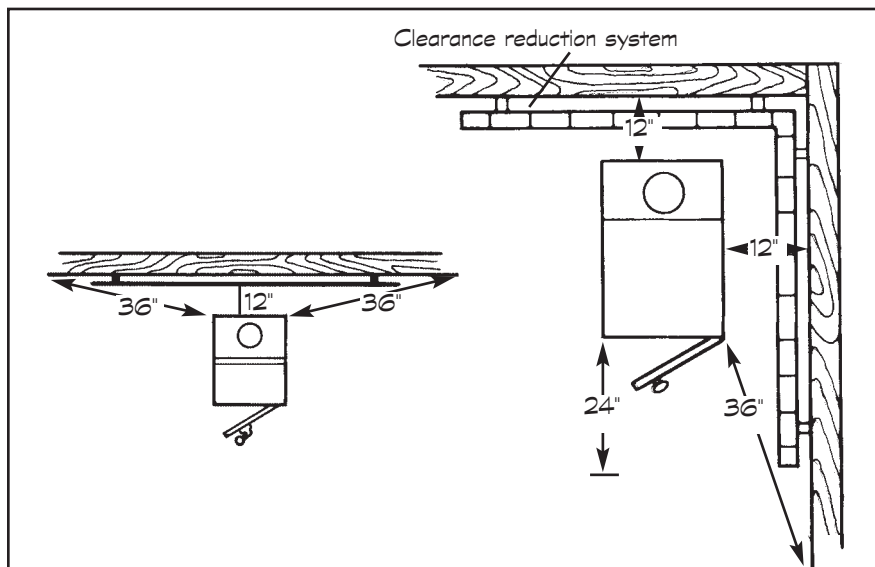


Diagram 3

A clearance reduction system using sheet metal or masonry can be used to safely shorten the distance from stove to combustibles.

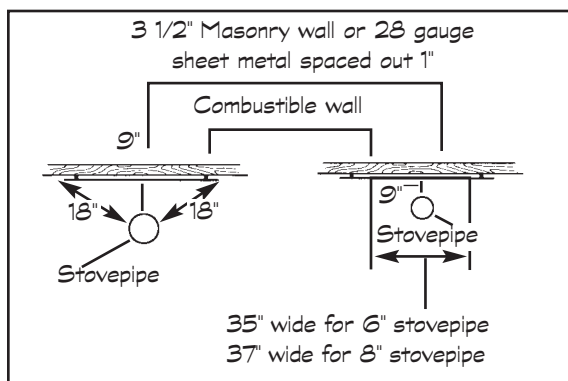
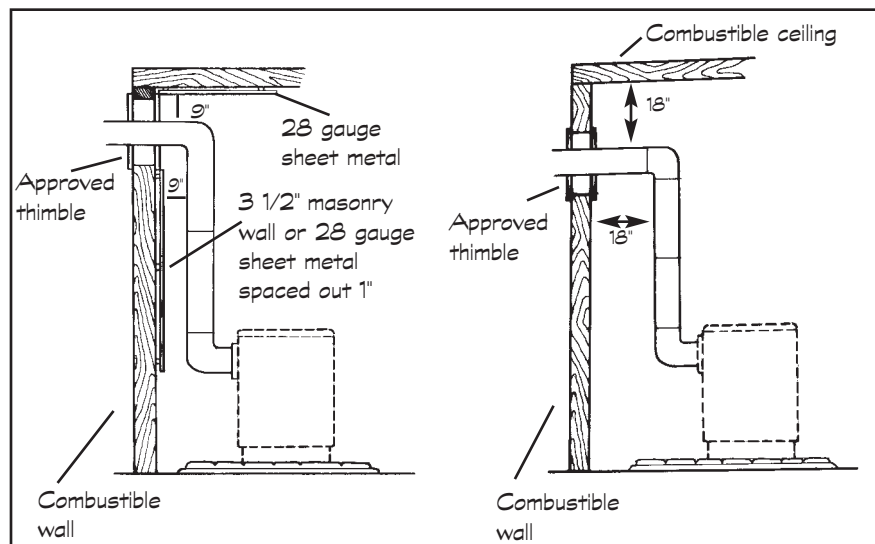


Diagram 4

For a 6-inch stovepipe, the protection must be 35 inches wide; 37 inches for an 8-inch stovepipe.

Diagram 5

Without protection, a stovepipe can be no closer than 18 inches to combustible ceilings and walls. By using a masonry wall or sheet metal, spaced out 1 inch from the combustible wall, the distance from stovepipe to combustible surfaces can be shortened to 9 inches.



**Table 2: Clearances Using Clearance Reduction Systems**

TYPE OF PROTECTION	WOOD	STOVEPIPE
3-1/2" masonry wall spaced out 1"	12"	—
24 gauge sheet metal spaced out 1"	12"	9"
Prefabricated system	per manufacturer's specifications	

**Notes:**

1. These clearances are from the side of the stove or stovepipe to a parallel combustible surface.
2. Loading doors require at least a 24-inch clearance, even with clearance reduction systems or noncombustible surfaces, to allow room for loading the stove..
3. There must be at least a 36-inch clearance from the top of the stove to any unprotected combustible surface.
4. Use these clearances or those contained in the manufacturer's instructions, whichever is greater.
5. Masonry clearance reduction systems are used on walls, not ceilings.

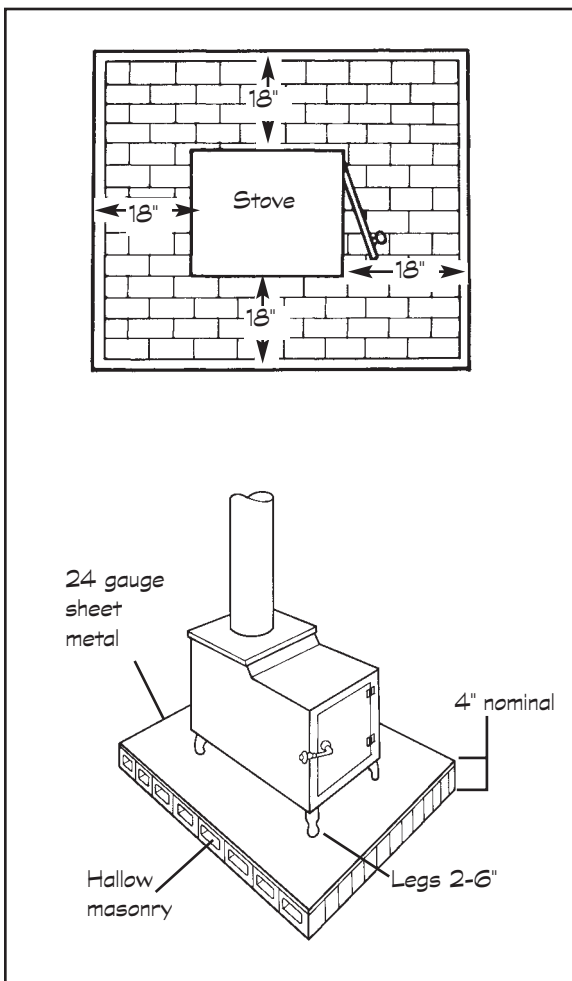


Diagram 6

Floor protection must extend 18 inches in all directions. For stoves with 2-6 inch legs, you must protect a combustible floor with 4-inch masonry arranged to allow air flow, and 24 gauge sheet metal.

An unlisted stove requires 18 inches of floor protection on all sides, including the loading and ash doors.

If more than one safety listed prefabricated stove board is needed to meet the clearance requirements, the junction between the stove boards should be made using either a safety tested and listed stove board adapter or a strip of 24 gauge sheet metal four to six inches wide.

The type of floor protection recommended depends on stove leg length. Stoves with legs less than two inches in height must rest only on floor protection as specified by the manufacturer, safety tested and listed prefabricated stove boards, or a noncombustible floor.

If your stove has legs two inches or greater in height, you are also allowed to use a combination of sheet metal and masonry. The arrangement of sheet metal and masonry for floor protection depends upon the length of the stove legs:

- Stoves with legs two inches to six inches: Floor protection can consist of four-inch (nominal) hollow masonry laid to provide air circulation through the layer and covered with 24 gauge sheet metal. Another layer of masonry may be laid over the sheet metal for aesthetic appeal.
- Stoves with legs higher than six inches: Floor protection can consist of closely spaced masonry units of brick, concrete or stone that provide a thickness of not less than two inches. Such masonry must be covered by or placed over 24 gauge sheet metal.

If you use a combination of sheet metal and masonry for floor protection, be sure that each stove leg has a firm, solid footing.

## Information Resources on the Web:

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### General Information/Industry Associations

<http://hearth.com/> – Hearth industry web site features links to manufacturers, products, and related information about wood heating.

<http://www.pelletheat.org/> – Pellet Fuels Institute web site features information about pellet heating and equipment.

<http://www.hpba.org/> – Hearth, Patio, and Barbecue Association web site has information on products and alternative fuels.

<http://www.mha-net.org/> – Masonry Heater Association of North America web site provides information on masonry heating.

<http://www.woodheat.org/> – The Wood Heat Organization web site. A non-commercial Canadian organization dedicated to promoting the merits of wood heating for homeowners.

<http://www.nfpa.org/> – National Fire Protection Association web site. The NFPA is a non-profit organization that develops and provides scientifically based consensus standards, research, training and education concerning fire safety.

### Government

<http://www.commerce.state.mn.us/> – Minnesota Department of Commerce web site. Features a wide variety of energy and consumer information.

<http://www.health.state.mn.us/> – Minnesota Department of Health web site.

<http://www.buildingcodes.admin.state.mn.us/> – Information on the state building code.

<http://www.dps.state.mn.us/fmarshal/> – Office of the State Fire Marshall web site.

<http://www.pca.state.mn.us/> – Minnesota Pollution Control Agency web site. Background information about global warming and climate change.

<http://www.cpsc.gov/cpscpub/pubs/556.html> – Consumer Product Safety Commission publication, “Your Home Fire Safety Checklist.”

<http://www.epa.org/> – U.S. Environmental Protection Agency (EPA) website).

## Minnesota Department of Commerce

Suite 500

85 7th Place East  
St. Paul, MN 55101-2198  
www.commerce.state.mn.us

## Energy Information Center

Twin Cities:  
651-296-5175

TTY: 651-297-3067

Statewide toll free:  
1-800-657-3710

E-mail:  
energy.info@state.mn.us

This information will be made available, upon request, in alternative formats such as large print, Braille, cassette tape, CD-ROM.

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MINNESOTA  
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## Minnesota Home Energy Guides

This guide is one in a series of publications designed to help Minnesotans save energy in their homes. Copies of the titles listed below are available by calling or contacting the Minnesota Department of Commerce.

**CD-ROM** contains all of the Home Energy Guides as well as several other publications of interest to homeowners, builders and contractors.

**Appliances** advises consumers on what to look for in energy efficient appliances and includes information on efficient operation and maintenance of refrigerators, freezers, washers, dryers, dishwashers, cooktops, ovens, and home office equipment.

**Attic Bypasses** explains how to find those "hidden air passageways" and fix them to prevent costly heat loss and damage to roofs, ceilings, walls, and insulation.

**Basement Insulation** discusses the pros and cons of interior vs. exterior insulation and provides detailed how-to instructions.

**Caulking and Weatherstripping** describes how to identify sources of air leaks, lists various types of caulk and weatherstripping, and provides illustrated how-to-apply instructions.

**Combustion & Makeup Air** describes the causes of dangerous combustion air problems and tells how to install an outside combustion air supply. It also tells how to test your home for combustion air problems.

**Energy Saving Landscapes** describes how to use trees and shrubs for long-term energy savings, and lists trees appropriate for energy-savings.

**Home Cooling** tells you how to cool without air conditioning, and provides information on buying and operating energy efficient air conditioners.

**Home Heating** describes proper maintenance techniques and helps you become an educated shopper if you are buying a new heating system.

**Home Insulation** helps the homeowner evaluate the benefit of added insulation, providing information on buying and installing insulation.

**Home Lighting** looks at new technologies for residential lighting, identifying four basic strategies and providing examples for putting them into practice.

**Home Moisture** describes symptoms of moisture problems, lists common indoor and outdoor causes, and discusses preventive and corrective measures.

**Indoor Ventilation** describes the types of home mechanical ventilation systems that are available, the amount of ventilation air needed, and how best to operate and maintain the system.

**Low Cost/No Cost** addresses the often overlooked energy saving tips for all areas of your home.

**New Homes** discusses a wide range of options for increasing energy efficiency beyond the normal building code requirements. Subjects covered include insulation, ventilation, air-vapor controls, heating and cooling, windows, doors, and appliances.

**Water Heaters** helps you determine whether to buy a new water heater or improve the old one. It explains the efficiency of different types of water heaters and provides installation tips.

**Windows and Doors** helps you decide whether to replace or repair windows or doors and gives a good summary of energy efficient replacement options.

**Wood Heat** offers advice on purchasing and installing a wood stove, with special emphasis on safety.